

(6) Change of direction can be produced (just as it can in a planing bird) by lateral tilt of the body.

(7) Rise and fall are certainly possible (due to forcing up of air by waves), but I have been unable to observe any cant of the planes which produces this.

(8) The fish can easily outstrip a vessel doing 17 knots.

(9) The majority of fish turn into the wind when launching themselves. On December 12, 1919, simultaneous observations were made by two observers for periods of $1\frac{1}{2}$ minutes upon the windward and leeward sides of the ship. Twice as many fish "flew" to windward as to leeward. In some counts the results were as high as eight to windward without a single fish going to leeward.

(10) They can remain in the air for at least half a minute (I fancy I have seen much longer flights when in the cable ships). On December 18, 1919, the following flights were timed:—10 seconds (three times), 15 seconds (four times), 25 seconds, with tail

muscle being downwards and forwards, and not downwards and backwards.

(15) The structure of these muscles is altogether unlike that familiar in muscles performing the short, quick strokes of flight, but is entirely what would be expected of muscles acting tonically as spreaders of planes.

F. WOOD-JONES.

University of Adelaide.

"Space" or "Æther"?

PROF. EDDINGTON (NATURE, April 14, p. 201) challenges those of us who have asserted that "relativity does away with the æther" to defend our statement. He himself provides our defence. He tells us that *his* æther—the æther that relativity does *not* do away with—"has not . . . density, elasticity, or even velocity."

But *our* æther—the æther of pre-relativity days, which relativity *has* done away with—has all those properties. In particular, it has the last. The nineteenth-century æther simply was a system relative to which light had the normal and invariable velocity c ; so that the velocity of light relative to a system which had, relative to the æther, the velocity v was $c+v$. That statement conveys the very meaning and essence of the old æther; deny it, and the Fizeau and Michelson-Morley experiments lose all significance.

Prof. Eddington's word "æther" has neither the denotations nor the connotations of the old word. His use of it will receive the support of Humpty-Dumpty, but not of those who consider that accuracy of thought is intimately dependent upon the constancy of the meaning of the words used to express it.

NORMAN R. CAMPBELL.

I AM indebted to Prof. Eddington (NATURE, April 14, p. 201) for pointing so decisively to the full issues of my argument (NATURE, April 7, p. 171). The position may be clinched thus:—The relativists may take away *pure space* as an objective entity, but in so doing they are "ætherising" or materialising the space of the physical universe. So the physicists get back their "æther" with something more; and "space," a fundamental fact of human experience which has been such a metaphysical enigma right down the ages, at least becomes intelligible as the substratum of matter. The identification of

æther and space provides a mechanism of the universe, and will enable us to picture physically what is meant by such phrases as "world-lines" and "twists in space."

Prof. Eddington's reason why the quality of beauty is not included in physical science and my own are metaphysically identical, and the two propositions, very differently framed, confirm one another.

April 16.

L. C. W. BONACINA.

Meteors on the Moon.

THE reported failure of Prof. Goddard to obtain pecuniary support for his project to discharge a giant rocket at the moon leads me to ask a question which astronomers may answer. Why is it that no observer has ever reported the descent of a meteor upon the surface of our satellite? It seems reasonable to suppose that meteoric falls must occur there as upon the surface of the earth. According to the accepted estimate, the earth receives about 20,000,000 meteorites per diem. If that holds good, *mutatis mutandis* :

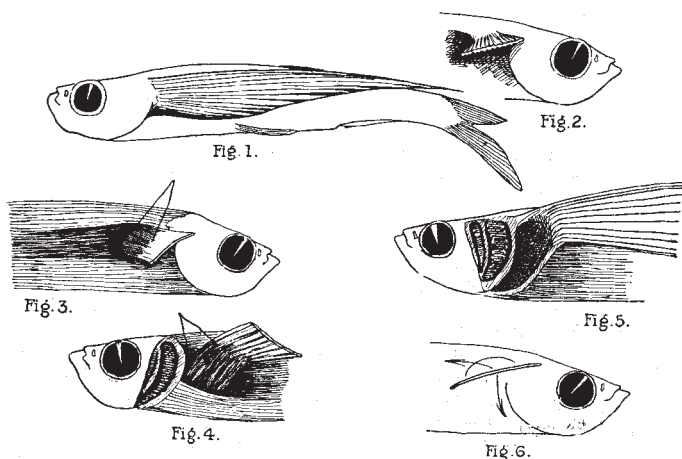


FIG. 1.—General lines upon which the fish is built.

FIG. 2.—The pectoral fin was placed in the position of flight, and the specimen then hardened in formalin. The right fin is represented cut through near its base.

FIG. 3.—Dissection of the dorsal or posterior muscle (tinted), showing the depression in the general longitudinal muscle mass of the body into which the fin fits when hauled up and back by its retractor muscle. The tinted muscles in Figs. 3 and 4 are indicated by the lines A.

FIG. 4.—Dissection of the ventral or anterior muscle (tinted). Numerous tendons pass the fin-rays from small pale muscle. Evidently the muscle hauls the rays and spreads the wing like a fan.

FIG. 5.—The ventral muscle removed to show the depression in the gill base skeleton which it occupies.

FIG. 6.—Diagram to show direction of action of the two muscle masses.

splashes (twice), 28 seconds (numerous tail splashes, once), and 30 seconds (numerous tail splashes, once).

(11) The dorsally situated mouth and the enlarged ventral fluke of the tail-fin tell clearly that the fish is one designed to make rushes *upwards* through the water in search of food.

(12) Its "flight" is only an extension of the flight of the garfish. These fish also launch themselves into the air, and without any planing, but merely by their impetus, travel for a sufficiently long and rapid "flight" to carry them—like a hurled spear—right through the sail of a boat.

(13) Only two main muscle masses are attached to the base of the pectoral fin. The posterior muscle pulls the fin upwards and backwards and folds it into the "slot" for its reception. The anterior muscle pulls the fin downwards and forwards and spreads it as a plane.

(14) These muscles do not produce "flight" movements of the fin, the stroke of the ventral (anterior)

the moon, our luminary must receive about 2,000,000 in twenty-four hours. The great majority of these would necessarily be invisible. One-half of the number would fall on her averted face. Of the remainder more would fall during sunlight than during the hours of darkness. Of those that fell during hours of darkness the greater number would be concealed by terrestrial cloud. Of those that were not so concealed one-half would fall on the illuminated part of the moon's disc, and, perhaps, be rendered invisible by the lunar brightness. It is easy to see that large abatements must therefore be made from the number of falls if we wish to estimate the probability of making a successful observation. This consideration has a bearing, by the way, on the reasonableness of expecting to be able to witness the arrival of Prof. Goddard's projected rocket if the aim were good and a hit secured; but that is by the way.

If, in consideration of all these adverse contingencies, we reduce the estimate of impacts to 1 per cent. of the above-quoted figure, we have 20,000 hits on an average moonlight night. Why has not one of them ever been observed? Among the number of meteorites must be a certain proportion weighing one or two hundredweight or more. When masses of that magnitude enter our atmosphere they grow incandescent and light up a whole countryside, it may be for some seconds. That is the result of impact upon our yielding atmosphere. If they reached the surface of the earth, as presumably they do that of the moon, with cosmic velocities ranging up to 40 miles a second, would they not break up there with an outburst of light like that of a nova among the stars? Furthermore, as these impacts must include not only single masses of considerable size, but also meteoric showers, the areas affected must presumably at times be large enough to be quite observable through a good telescope. It may be suggested that when the fall is normal, or at any large angle to the moon's surface, the projectile buries itself too deeply in the substance of the moon to be visible. But among the arrivals must be some that arrive at grazing, or something like grazing, incidence on the moon, penetrating little, or not at all, beneath its surface. Why are their glowing paths never seen and the furrows which must so have been ploughed, in the course of ages, upon the moon's ancient surface never described to us?

Probably there is an easy answer to these questions, but, even if easy, it would be interesting to those of us who are not astronomers.

J. W. GORDON.

11 King's Bench Walk, Temple, E.C.4, April 12.

THE question of meteors on the moon is not now raised for the first time. In my article on astronomy in "Science in Modern Life," vol. i., p. 35 (I give this, not as being the first mention of the subject, but because it is the most accessible source), I wrote:—"There is one puzzling question raised by Prof. Shaler, i.e. how is it that the fall of meteors on the moon, which must be as dense as those falling on the earth, has not covered all the markings with a veil and obliterated the differences of tint? It has, however, been calculated that even if the atmospheric density at the surface be only 1/10,000 of that on earth (a quantity which it may well exceed), then, since the rate of decrease is so much slower than on the earth, at a height of something over 40 miles the densities of the atmospheres would be equal, and at still greater heights that of the moon would be the denser. Now most of the meteors that enter our air are completely burnt up at greater heights than this, so that the thin lunar atmosphere may actually be as effective for stopping meteors as our own."

It is comparatively rarely that meteors reach the

earth's surface, and when they do so the speed has been so diminished by friction that there is no intense flash. The above reasoning makes it quite possible that the conditions on the moon are similar. If so, an impact-flash bright enough to be seen from the earth would be extremely rare, and then it would be seen only if an observer with a powerful telescope happened to be looking at the right spot at the right moment. There are also very few meteors the flash of which in the atmosphere of the earth would be bright enough to be seen from the moon. Some furrows on the Mount Wilson lunar photographs might, however, possibly be due to meteor falls.

ANDREW C. D. CROMMELIN.

Calendar Reform.

THE simplified calendar proposed by the Rev. E. Fanfani and described in NATURE of March 17, p. 88, is apparently inspired by a sound principle, viz. to make the minimum of change in existing conditions. It is, however, very desirable, if the months are otherwise to remain unchanged, to secure that the existing inequality in the lengths of the half-years and quarters should be corrected.

The late Prof. Millosevitch, of Rome, with whom I corresponded on the subject, expressed the view that this was the greatest—indeed, in his opinion, the only great—defect of the present calendar. This object can be effected by taking a day from August and adding it to February—a change which was suggested in NATURE of February 23, 1911, although its value was not, I think, fully appreciated at the time. This change can be made without altering the date of the vernal equinox (as fixed by the Papal Bull of February 23, 1582) by adding the day taken from August to the February of the following year. This alteration has the important advantage of giving us four quarters each containing three months and (the 365th and 366th days being apart from the week) exactly thirteen weeks. A common measure for the relation of monthly and weekly values would thus be available—a matter of much importance in accounting.

As regards the exact relation to be established between month-day and week-day, if, as M. Fanfani proposes, the leap day is to be left in its present position, which is in several respects desirable, facilities should be provided for terminating a quarterly period at the end of February. This is best accomplished by beginning with a Sunday on December 1. That would be the permanent date of Advent Sunday—the true *beginning* of the ecclesiastical year. The *central* day of the ecclesiastical year would then be May 31, which might be most appropriately selected for exclusion from the weekly series.

Of the five (or for the next 279 years four) dates of Easter Sunday possible under such a calendar one would be April 12. When Easter Sunday fell on that day Pentecost would fall on May 31. If Easter Sunday were fixed for that day, May 31 would be the annual permanent Pentecost, the founders' day of the Christian Church.

If Easter Day were allowed to oscillate over the four possible Sundays, it would be ascertained by the existing Easter tables without disturbance, and still always fall during evening moonlight.

Ecclesiastically, I submit that these proposals are equally simple with, and present superior advantages to, those suggested by M. Fanfani. From the point of view of legal administration, commerce, and accounting they are effective in removing the defects in the working of our present calendar.

The above changes could be introduced without any disturbance or interruption in 1924-25.

March 19.

ALEXR. PHILIP.

NO. 2686, VOL. 107]